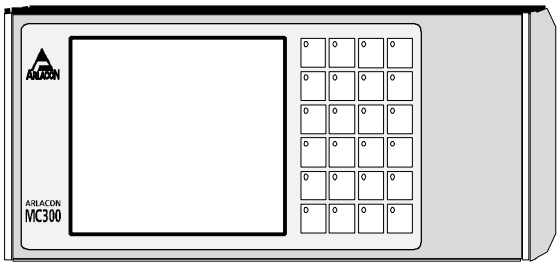
ARLACON MC300
Control system
user's manual



COMPACT SYSTEM

- up to 8 axes
- graphigal display
- ASCII keyboard
- McDos / McBasic
- RS232, RS232/422/485
- McWay 504/504 i/o each, 1,25ms

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CE

DECLARATION OF CONFORMITY

Manufacturer: Control Techniques SKS Oy

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Finland

Product: MC300 control units

conform to the following Directives and Regulations

EMC: Directive 89/336/EEC

Generic Standards: EN 50081-2
EN 50082-2

The purpose of this equipment is to be used as a part of the electrical system of an industrial machine. It is therefore essential that the installation and use of the product are executed according to manufacturer's instructions and specification. When installed as described in manufacturer's documentation, the equipment conforms to the requirements of the described standards. However, the final responsibility for the conformance of the complete installation and machinery where the equipment is being used is left with the manufacturer of such apparatus. In certain cases it is necessary to perform additional tests to confirm the EMC performance of the complete system.

Vantaa 14.3.97 Control Techniques SKS Oy

A. Lindvall

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1. INTRODUCTION

Welcome to use the ARLACON MC family of control products. Like other ARLACON control systems the MC300 combines simple and compact system structure with powerful system software and programming tools.

The MC300 features continuous path servo control for up to 8 axes, expandable i/o connections and RS-232/422 communications. Additionally, MC300 combines a user terminal with an lcd graphics/text display and a function keypad in the same control unit.

This manual contains information on installing and using the MC300 control system. Please study the following chapters carefully before starting to work with your system. Also refer to the ARLACON McWay I/O system user's manual and the McBasic programming environment reference manual where applicable.

In case you have questions or suggestions concerning this manual, the MC300 or other ARLACON products, please contact your ARLACON dealer or the manufacturer:

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1.1 GENERAL

The MC300 control unit combines a programmable control computer with a 320x240 pixel backlit graphical/text lcd display and a 24key function keypad with programmable led indicator lamps.

The MC300 is equipped with two serial interfaces that can be used for communications or networking, a connection for standard ASCII keyboard and a McWay connection for the i/o system.

To get the MC300 operating you only need a 24Vdc power supply and a terminal or a PC for programming.

The MC300 can also be configured as a "Dumb terminal" for use as user interface terminals for ARLACON control systems or other systems using RS-232, RS-422 or optical fibre communications.

1.2 MC300 FLUSH MOUNT CONTROL UNIT

The MC300 flush mount version is designed for mounting on cabinet doors and instrument desks where it provides flexible user interface capabilities for all types of application.

It is available with either RS232 and optical fibre connections or RS232/RS422 connections.

1.3 MC300 CONTROL UNIT WITH ENCLOSURE

The MC300 version with aluminium enclosure is a fully enclosed version for bracket mounting on machine chassis or for use as a hand terminal. It is equpped with RS232/RS422 connections. An adapter module is available for using optical fibre connection.

1.4 MCWAY I/O SYSTEM

McWay i/o system is connected to the MC300 McWay connection to operate as a fast ring topology serial network with down to 0,5 ms refresh rate.

McWay i/o modules use standard rail mounting and terminal blocks to provide easy panel assembly.

MC300 is available with either RS-422 or optical fibre McWay and serial interface version. The RS-422 signal enables use with twisted pair cables whereas the optical fibre provides optimum EMC performance and fast communications for up to 50m distances. RS-232 is provided for short distance communication with a PC or other data equipment.

The MC300 hand terminal version with enclosure is equipped with RS-422/232 signals. Optical fibre communications can be obtained using the WGT02310 transceiver module with it.

The 1,25ms refresh rate means that input information for the control unit and data on the output modules are never more than 1,25ms old. Thus, it is possible to perform closed loop servo control with the remote servo axis connection modules.

More details of the operation of McWay modules can be found in the ARLACON McWay i/o system user's manual.

1.5 MCBASIC PROGRAMMING LANGUAGE

The McBasic is a programming environment developed for use with ARLACON control systems. It combines the ease of the standard Basic programming language and interpreter type interactive programming and testing with a fast runtime compiler, multitasking capabilities and powerful logic and motion control commands.

The McBasic version in MC300 runs under McDOS operating system allowing use of McDOS file and communication systems and utility programs. By using a WAKEUP.EX start-up batch file the system can be set to directly start at system power-up and automatically run the application program if loaded in memory or from some of the available memory devices.

MC300 supports 16 logical axes of which up to 8 can be physical axes controlled by the system simultaneously. Up to 504 input bits and 504 output bits can be connected via the McWay I/O system.

With its full floating point mathematics, strings, arrays, functions and structures, McBasic gives you tools for effective programming of work cycles, interactive user interfaces, communications and data processing. Up to 32 simultaneous tasks can run in MC300. Tasks can also be created and killed at any time by the application program.

The McBasic programming language is described in detail in the ARLACON McBasic programming environment reference manual.

2. INSTALLATION AND ASSEMBLY

This chapter describes the different versions of MC300 and the procedures for installing them in your system.

> ! For any work on the connections or inside parts of the unit, the power supply must be disconnected. Any such action on a unit with power on may cause damage to the unit or equipment connected to it.

2.1 MC300 FLUSH MOUNT INSTALLATION

The MC300 flush mount version is designed for mounting on doors, consoles etc. For installation, cut a mounting hole according to fig. 2.1.1. Also drill holes for the 4 screws required for fastening the unit.

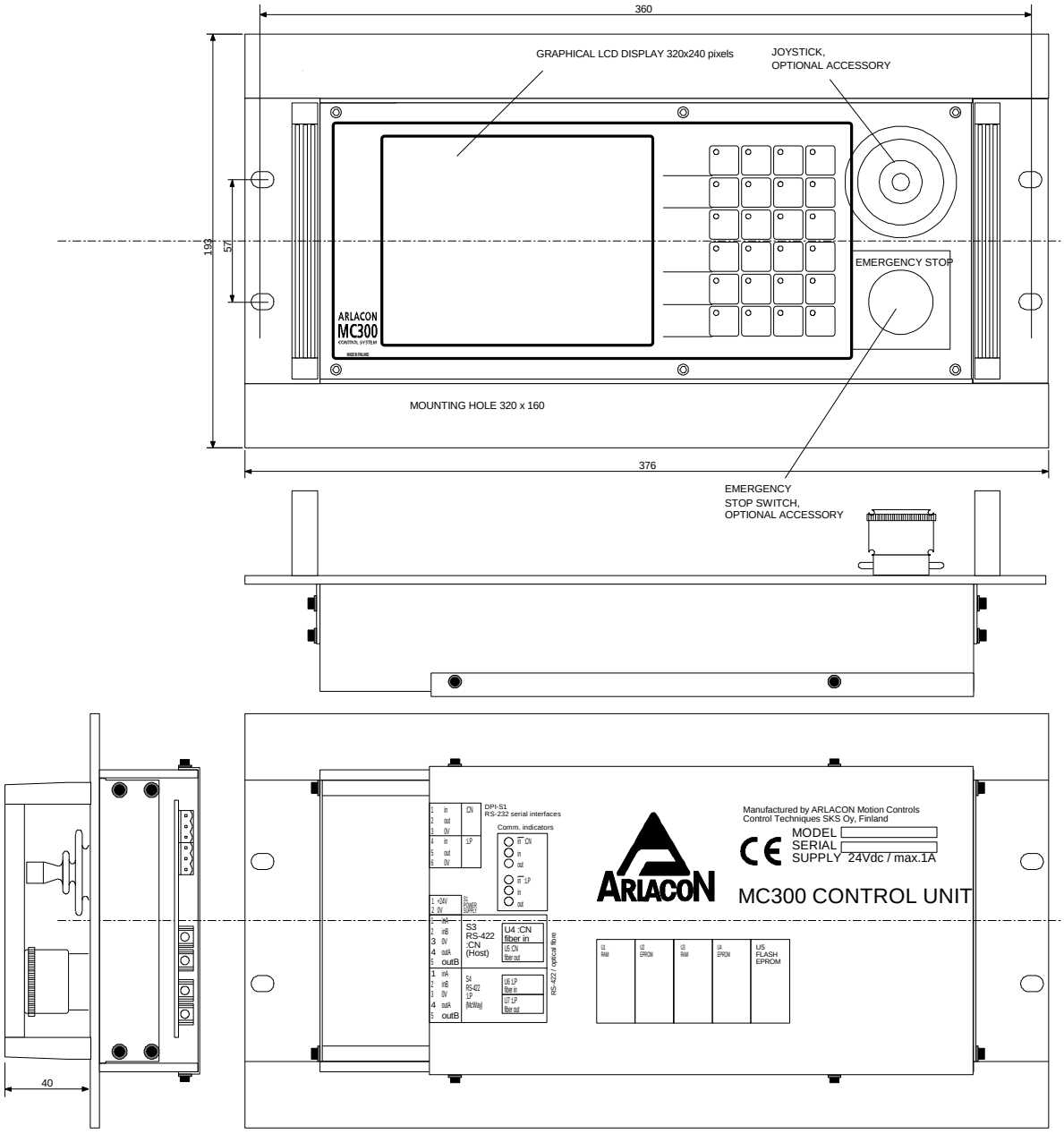

Fig 2.1.1 MC300 flush mount version

When installing the unit, insert it through the mounting hole from the front side and fasten with screws. Use M6 screws for mounting. When mounting through metal surfaces like a control system cubicle or control panel, be sure to clean the surfaces and use the washers supplied to ensure good electrical connection through each screw for specified electromagnetic compatibility.

The display/keyboard plastic membrane of the MC300 has transparent windows over the keyswitches to enable use of custom legends on the switches. A white plastic background with holes for the led lamps is also supplied for use with legends printed on transparent plastic. Optionally, the MC300 can be delivered with a customer specific front plate.

To change the keyboard legends, first remove the 6 screws holding the plastic front plate. Then lift off the front plate to access the keypad cavity behind the plastic membrane.

Customer specific legends can be printed out for example with a laser printer and a suitable drawing program. Such printouts can also be ordered from the manufacturer. Fig. 2.1.2 shows the dimensions and layout of a keypad legend slip.

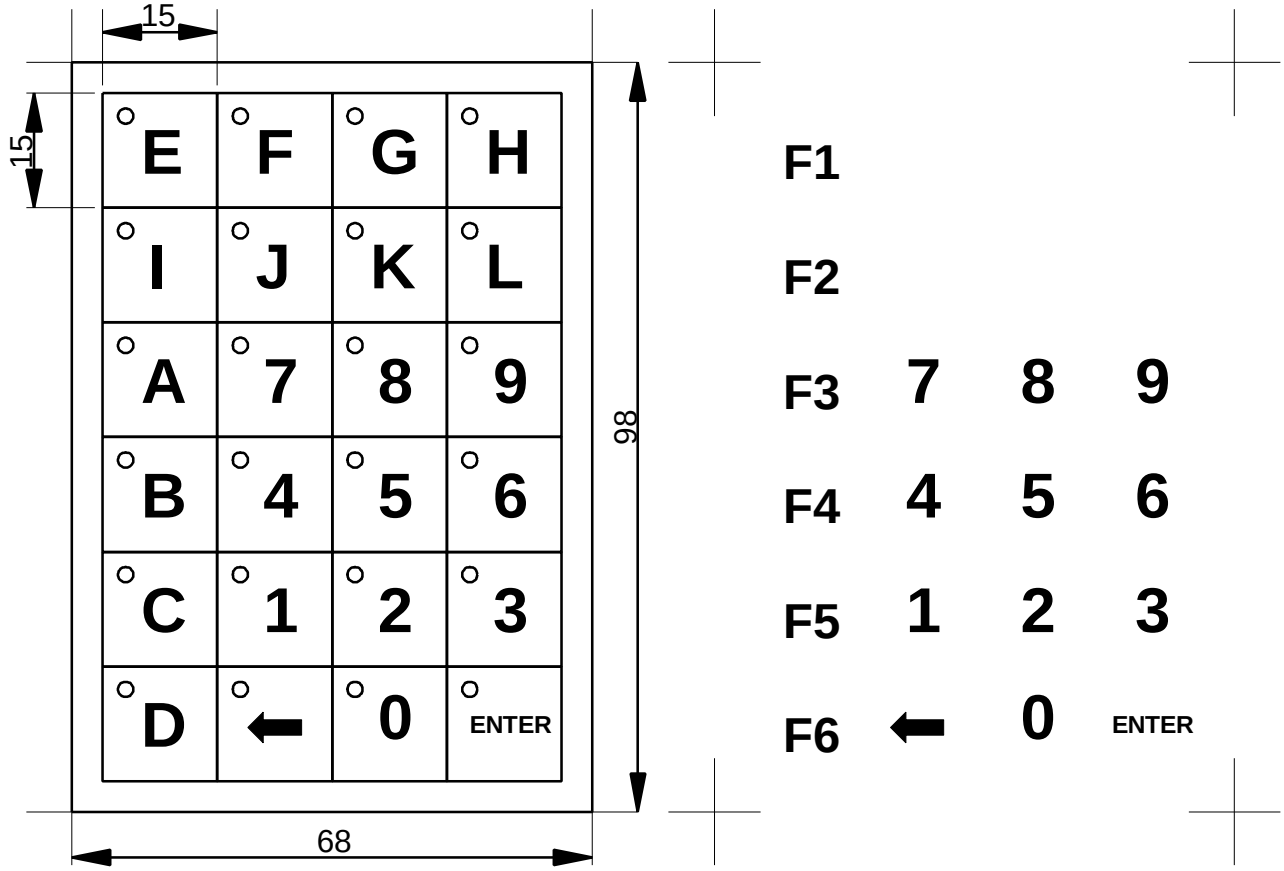

Fig 2.1.2, Keypad legend slip

2.2 MC300 with enclosure

The MC300HTR with aluminium enclosure is designed for use as a hand terminal or for mounting on machines, walls etc. A support bracket with hand screws is also available. The enclosure is also equipped with two D-15 and a 5 pin DIN female connectors for electrical connections.

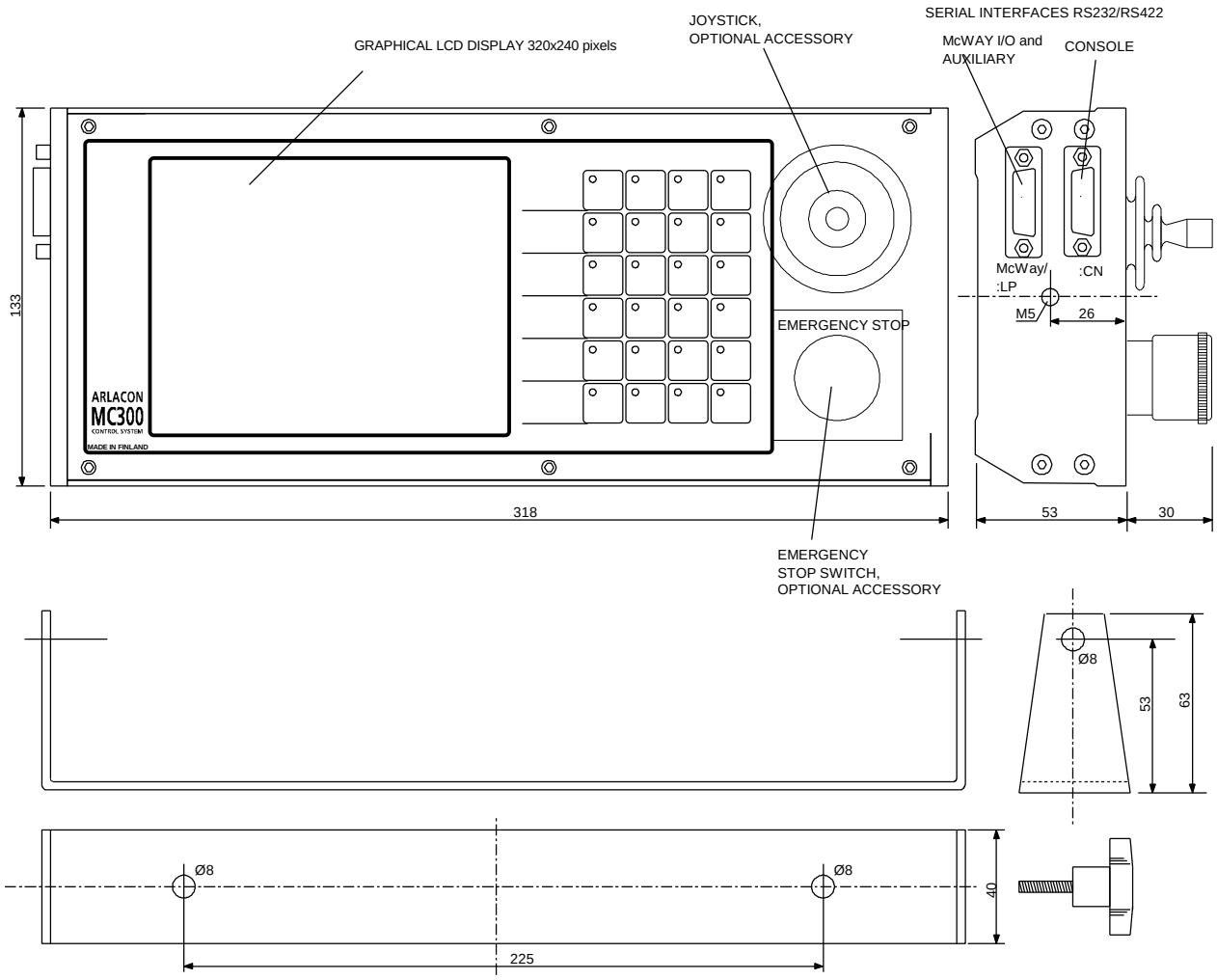

Fig. 2.2.2 MC300HTR with enclosure.

To access the system board inside the enclosure, you can either open the back cover of the enclosure or remove the unit from the enclosure with its front plate.

To open the back cover, first remove the four screws on the sides of the cover. If necessary, also loosen the four screws on one of the end plates of the enclosure.

It is also possible to access the system board from the front side. To remove the front plate, first remove the 6 screws holding the plastic front cover. Remove the cover and remove the 6 screws on the sides of the front plate. You can now lift the metal front plate of the system with electricall parts attached. Disconnecting the communication flat cable, power cable and keyboard cable connectors allows removing the unit for service.

2.3 CONTROL UNIT ELECTRICAL CONNECTIONS

Fig. 2.3.1 shows the MC300 control unit system board. Additionally, a daughter board DPI02410 is used in panel/flush mount versions for connections. In the MC300 with enclosure the connections go through D-15 connectors via a connector card at the end plate of the enclosure. These boards both connect to the S2 connector on the system board (MCU1).

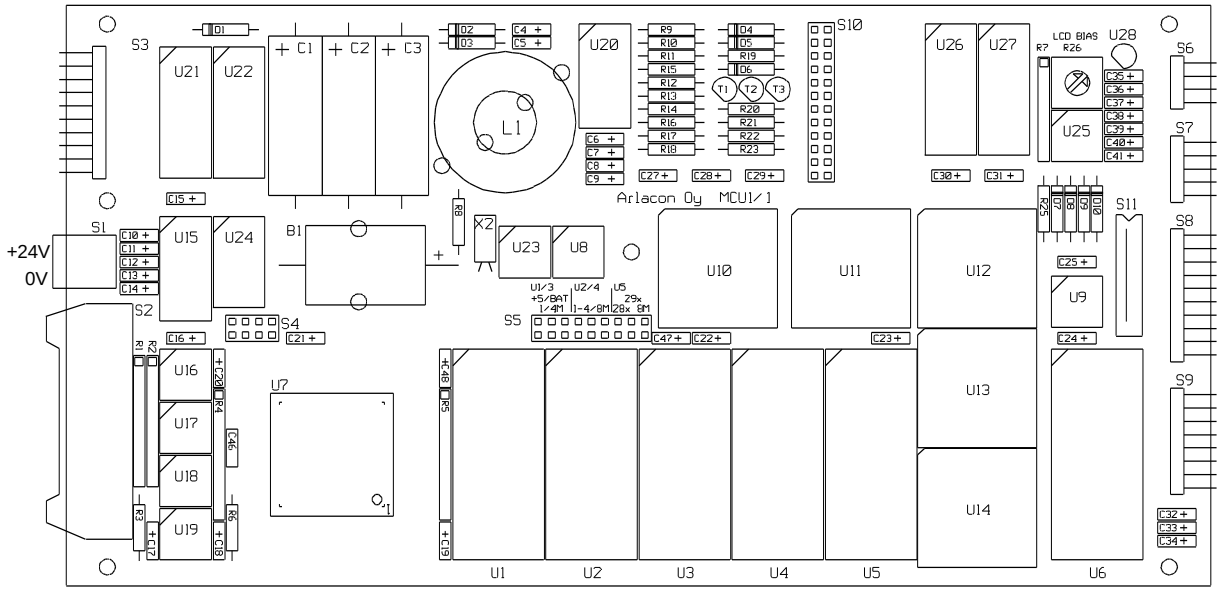

Fig. 2.3.1, MC300 system board

The following significant parts are located on the system board:

MC300	
S1	Power supply connector (20-28Vdc)
S2	Communications connector
S3	Analog I/O connector
S4	CPU service connector
S5	Memory type jumpers
S6	ASCII keyboard connector
S7	Function keypad connector
S8	LCD display connector
S9	EL display connector
S10	option connector
S11	2. LCD display connector
B1	Memory backup battery for CMOS RAM
U1	RAM 128k standard, 512k optional (odd bytes)
U2	System EPROM D8: (odd bytes)
U3	RAM 128k standard, 512k optional (even bytes)
U4	System EPROM D8: (even bytes)
U5	FLASH EPROM D6: , 256k standard, 512k optional
U6	Video RAM
U7	CPU
U10	McWay control logic
U11	I/O control logic
U12-14	Display control logic
U15	RS-232 buffers
U16	CN: RS-422/485 output buffer
U17	CN: RS-422 /485 input buffer
U18	LP:/McWay RS-422/485 output buffer
U19	LP:/McWay RS-422/485 input buffer

U20	Power supply
U21	A/D converter (optional)
U22	D/A converter (optional)
U23	Realtime clock
R26	Contrast adjusting potentiometer

2.3.1 Power Supply

The power supply requirement for the MC300 is 24Vdc nominal (min. 16Vdc, max. 30Vdc) 0,7A typical 1A max. at 24V. An unregulated filtered dc power supply can be used. Note, that the use of a power supply equivalent to the types supplied by your ARLACON distributor for use with MC300 is necessary to ensure EMC conforming to EC directives.

When building complete systems with MC300 and McWay i/o modules note the system overall power requirement when using the same power supply.

In the MC300 flush version the power supply is connected to the S1 connector on the system board.

S1 pin	
1	+24V
2	0V

In the MC300 enclosed version the power supply is connected on either of the D-15 connectors. The same cable, which is used for communications, can also be used for power supply.

:CN/:LP pin	
14	+24V
6	0V

2.3.2 Communications setup

There are two communications channels available on the MC300 unit. Both channels have signal connections for RS232 and RS422/RS485 type physical signals. The channels can be run at any standard baud rate between 300 -38400 bit/s.

The system uses XON/XOFF handshake. No hardware handshake signals are available.

The default communications parameters for both channels are:

transfer rate	9600 bit/s
data	8 bit
parity	no
stop	1 bit
handshake	XON/XOFF

The communications parameters can be set as described in the McBasic and McDos manuals using the SET command or in connection with commands such as PAATE (McDos) or OPEN (McBasic).

Although the MC300 communication can be configured to generate parity, incoming parity errors are ignored.

Console (:CN)

The :CN port is the default programming port or the console port of the MC300.

When connecting a terminal device such as a CRT terminal, a PC with a terminal program or an ARLACON program development system, the programmer can directly access the MC300 McDos operating system and the McBasic programming environment.

Alternately, using the McDos CNTO command, another port can be assigned to be the console port. This way for example

CNTO TR:

Redirects console operation to MC300 lcd display and keyboard. This command can be written in the WAKEUP.EX file run by McDos at power-up or used from an McBasic program with the McBasic SYSTEM() command. For example:

SYSTEM("CNTO TR:")

will redirect the console including ctrl-X operation to stop the program.

SYSTEM("CNTO CN:")

can be used to set console back to CN: port.

The console port can be used to edit programs, issue commands, upload and download programs and test the system.

When running an application program the CN: port or any port assigned to be the console, can also be used for any other communications purpose. However, the current console port always reacts to ctrl-X by stopping the McBasic program being run. Redirecting console can be used to avoid this when running protocols written to use also ctrl-X.

The MC300 can also connect to McNet RS485 local network via the CN: or LP: channel as a network peripheral device (see McNet documentation).

When starting the MC300, all logical devices (#nn, see McBasic user's manual) refer to the console port channel (default CN:).

Auxiliary communications channel (LP:)

The LP: port can be use for any communications purpose in the application. Initially, there are both RS-232 and RS-422/485 signals available for use with it. When connecting a McWay I/O system to the MC300, the RS-422/485 signals for LP: are automatically connected to the McWay I/O controller in the MC300. The RS-232 signals remain connected to the LP: port to allow simultaneous use with McWay I/O. If it is necessary to have other signal types for LP: while running McWay I/O, an optional WGT02310 module can be connected to convert to either RS-422 or optical fibre signals.

The :LP channel can be used for connecting devices such as a serial printer, other computer, barcode wand etc.

LP: McWay master signals

To use the MC300 with McWay i/o, the control unit must first be configured to use the number 0 McWay channel with the McBasic WAYMOD$ command. This will automatically connect the LP: port RS-422 signals or optical fibre signals to the MC300 internal McWay controller leaving

the RS-232 signals for use with LP: serial port. See McBasic manual and McWay I/O system manual for details on McWay configuration.

2.3.3 Communications connections

MC300 with DPI02410 connection board

The MC300 flush mount version is equipped with the DPI02410 connection board as standard. Two versions of this board are available, version A with connections for RS232/422 and version B with connections for RS232 / optical fibre. Use of optical fibre is recommended for McWay I/O system to ensure optimum EMC performance. The pinouts and connections on the connections board are shown on the cover of the unit and in Fig and Fig. 2.2.1.

The DPI02410 connection board also provides led indicator lamps for monitoring communications signals. These lamps can be seen through holes in the cover of the unit.

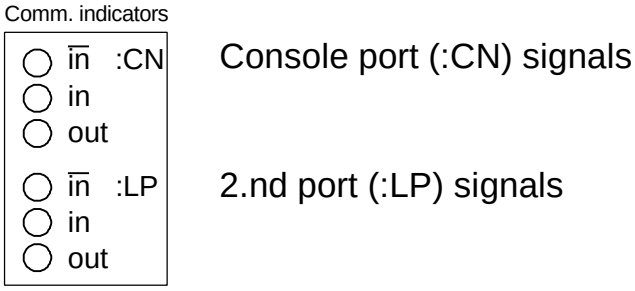

Fig. 2.3.3.1, DPI02410 indicator led lamps

MC300 with enclosure

The MC300 version with enclosure has communications connectors on the enclosure with the following pinouts:

pin	
1	Chassis ground
2	RS232 data in
3	RS232 data out
4	RS422 IN A
5	RS422 OUT A
6	Power supply 0V
7	Signal gnd
8	EMRG +
9	TTL-level CTS* in
10	TTL-level Tx enable out
11	RS422 IN B
12	RS422 OUT B
13	+5V
14	Power supply +24V
15	EMRG -

EMRG signals are used with the optional emergency stop switch. The emergency switch contacts are available on the EMRG+ and EMRG- pins at the CN: connector.

Further stop switches can be connected in series with the emergency switch by removing the right jumper S5 on the ADP02908 connector board in the MC300 enclosure. After removing the left jumper on S5, the emergency loop is open at CN: connector S3 +EMRG and -EMRG pins. Removing the right jumper opens the emergency loop at the LP: connector S4 respectively.

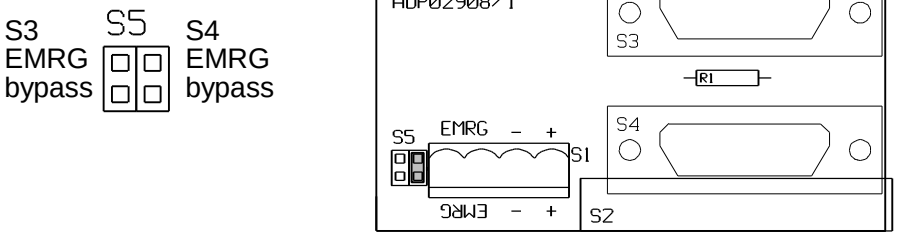

Fig. 2.3.3.2 MC200HTR with enclosure, communications connector board

A +5V voltages is available on the connector for use with equipment such as bar code wands and should not be loaded more than 100mA.

Fig. 2.3.3 shows an example where :CN is connected to a PC via RS232 interface and :LP is connected as a McWay i/o loop with one i/o module. The McWay connection is shown in the two versions: RS-422 (A) or optical fibre (B). Use of optical fibre is recommended for optimum EMC performance.

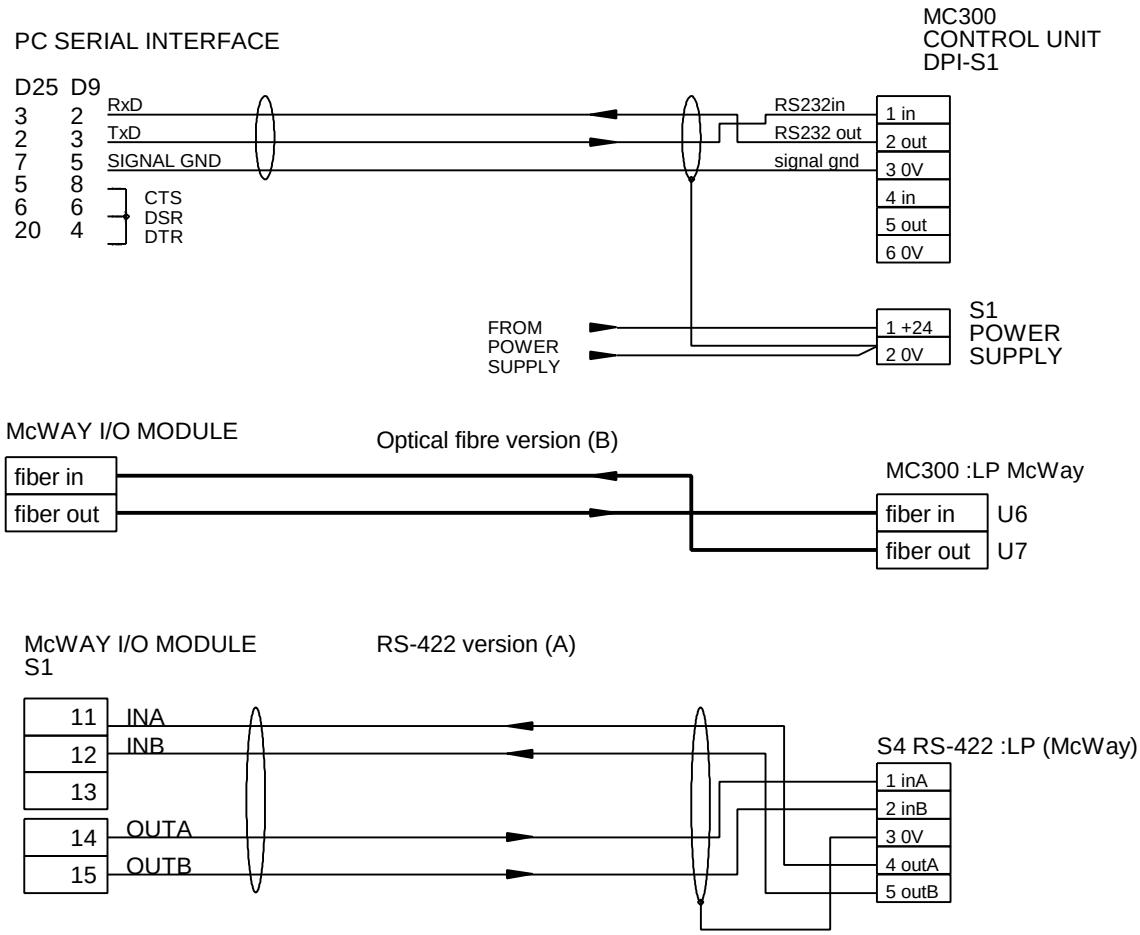

Fig. 2.3.3.3, Example of MC300 communications connections

2.3.4 WGT02310 Optical fibre/ RS232 /RS422 general transceiver

The WGT02310 transceiver module is a DIN rail mounting conversion module for use with optical fibre compatible with McWay equipment. It can be used for several purposes:

- To connect McWay modules to MC300 systems with optical fibre
- To connect McWay modules to MC300 systems with RS-422 with optical isolation in each segment.
- To provide isolation/optical fibre connection for MC300 serial communications
- To convert RS-232 signals to RS-422 or optical fibre

The WGT02310 has three input/output interfaces freely connectable to each other using onboard jumper blocks:

- 1 mm plastic optical fibre transmitter and receiver
- RS-232 /RS-422 with D-15 female connector compatible with MC300 with enclosure
- RS-422 with terminal block and optically isolated input

The D-15 connector has a separate 2 pin terminal block for EMRG signal connection.

Fig. 2.3.4.1 shows the parts of a WGT02310 module

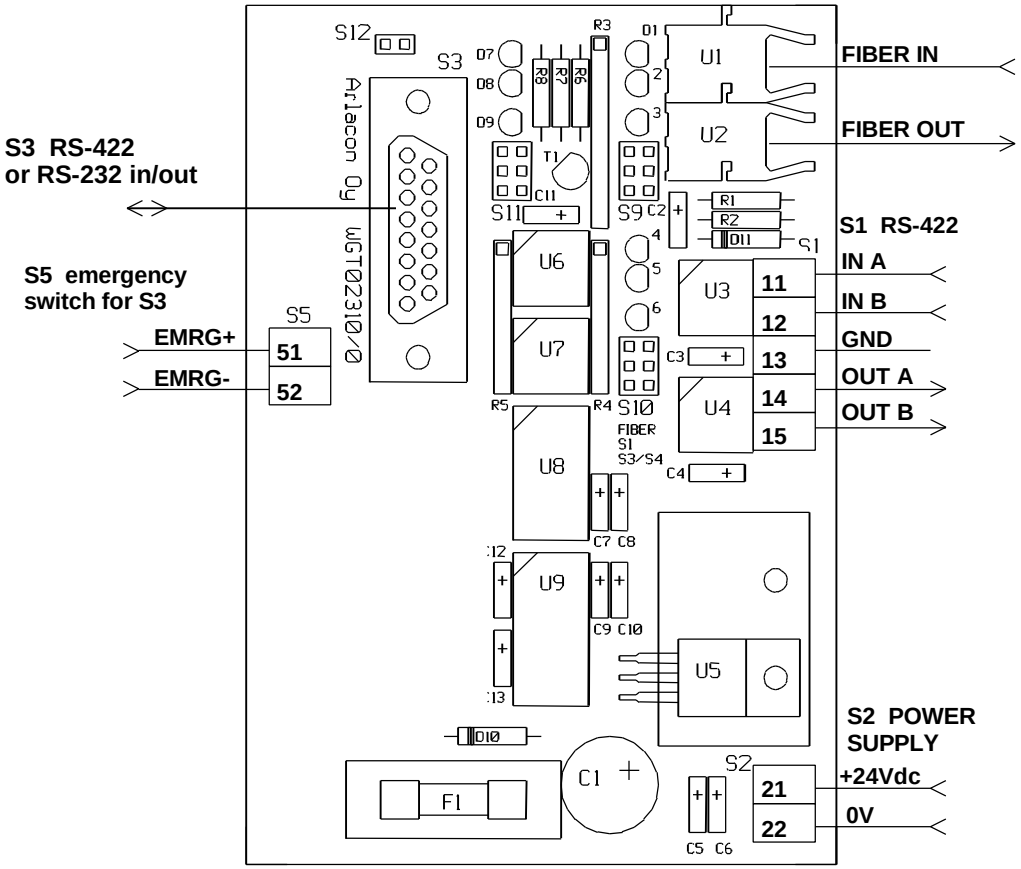

Fig. 2.3.4.1, WGT02310 general transceiver module.

FIBER IN (U1)	Optical fibre input
FIBER OUT (U2)	Optical fibre output
S1	RS-422 terminal block connector
S2	Power supply input connector
S3	RS232/RS422 D-15 connector
S5	EMRG connector for S3 EMRG signals
S9	FIBER OUT source selector jumper block
S10	RS-422 (S1) output source selector jumper block
S11	RS-232/RS-422 (S3) output source selector jumper block
S12	5V voltage source selector jumper
D1	Fibre input off indicator led
D2	Fibre input on indicator led
D3	Fibre output on indicator led
D4	RS-422 (S1) input off indicator led
D5	RS-422 (S1) input on indicator led
D6	RS-422 (S1) output on indicator led
D7	RS-232/RS-422 (S3) input off indicator led
D8	RS-232/RS-422 (S3) input on indicator led
D9	RS-232/RS-422 (S3/S4) output on indicator led
F1	24V power input fuse (1A)

Using jumper block S9-S11 it is possible to select any of the three input sources to connect to each output. Fig. 2.3.4.2 illustrates the interconnection possibilities.

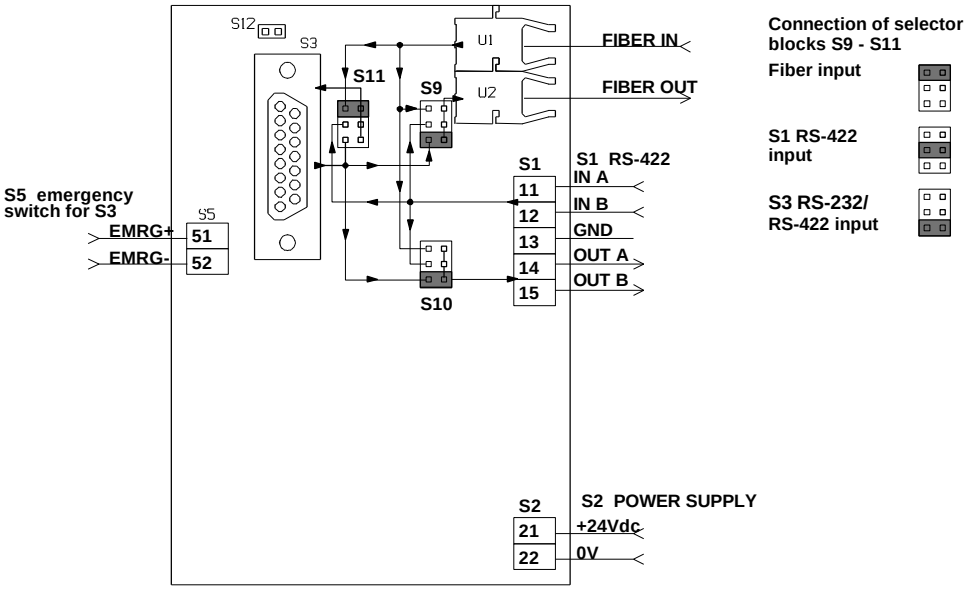

Fig. 2.3.4.2, WGT02310 interface interconnection with jumper blocks

Using led indicator lamps D1-D9 it is possible to monitor all inputs and outputs. Jumper S12 can be installed to supply the WGT02301 module from MC300 control unit via S3.

Do not install jumper S12 if you use 24V connected to S2.

The following table shows the pinout of the communications interface connector in WGT02310. It is compatible with similar communications in other ARLACON equipment.

To connect via the D-15 connector use a suitable cable with either RS-422 or RS-232 signals connected from "in" to "out". Other signals are connected pin-to-pin. Signals "frame gnd" are provided for connection of cable screens and are preconnected to supply 0V in WGT02310.

If used with MC300 version with enclosure, pins 6 and 14 can be used for connecting power from WGT 24V supply to terminal. In this case, do not connect pins 9,10 and 13.

WGT02310 S3 D-15 communications connector pinout

PIN	signal	PIN	signal
1	frame ground	9	(+12V)
2	RS-232 in	10	(-12V)
3	RS-232 out	11	RS-422 IN B
4	RS-422 IN A	12	RS-422 OUT B
5	RS-422 OUT A	13	+5V
6	0V (supply)	14	+24V (supply)
7	signal ground	15	EMRG-
8	EMRG+		

To supply power from MC300, connect S12 on WGT02310 board. Do not connect 24V supply to WGT02310.

2.4 MCWAY I/O MODULES

McWay i/o modules provide a method for building complete control systems using the ARLACON MC300 series control unit. Modules are available for connecting position feedback controlled axes with either incremental or absolute encoders, digital and analog inputs and outputs. Up to 504 output bits and 504 input bits can be connected to the MC300 McWay loop with a refresh period of down to 1ms.

Since the refresh rate of the McWay I/O loop coincides with the McBasic PIDFREQ setting, value >1000 will limit the number of input and output bits available. With PIDFREQ=2000 the refresh period is 0,5ms and the max. number of input and output bits is 240.

To use McWay modules with MC300 each module must be selected to operate at 1,25Mbaud. Further instructions about different McWay modules are available in the ARLACON McWay I/O system user's manual.

2.5 CONNECTING TO A TERMINAL OR PC

To program the MC300 it is necessary to connect a display terminal, a PC or ARLACON program development system to the :CN serial communications channel of the control unit.

To communicate, the MC300 only needs three wires connected:

signal at MC300	MC300 DPI-S1	MC300 w. encl. D-15	ARLACON D-25 female	PC D-25 male	PC D-9 male	
	pin	pin	pin	pin	pin	signal
RS232 in (RxD)	1	2———	———3	2	3	TxD
RS232 out (TxD)	2	3———	———2	3	2	RxD
signal ground	3	7———	———7	7	5	gnd
chassis ground	chassis	1———shield———				

For interference protection use shielded cable and connect shield to system ground (chassis) at MC300. Some PC computer programs also require pins 5,6 and 20 (D-25) or 8,6 and 4 (D-9) to be connected to each other to bypass hardware handshake.

For communications, please use a terminal program with xon/xoff handshake such as PROCOMM, PCPLUS, WINDOWS TERMINAL etc. Set the communication to 9600 baud, 8 bit, no parity, xon/xoff handshake.

With display terminals with connector pinouts different from above, please connect according to RS232 signal names.

2.6 EMC considerations

Electromagnetic compatibility (EMC) is an important design factor in industrial automation as well as in other electrical installations. The purpose of EMC is to ensure that electrical equipment emit electromagnetic energy (interference) less than can cause malfunction of other equipment. The difference between the level of emissions and the level of susceptibility is called the EMC margin.

There are different standards and regulations specifying the test and measuring techniques and acceptable levels for conducted and radiated emissions and immunity.

2.6.1 The European EMC directive

The European Union requirements for EMC are stated in the EMC directive 89/336/EEC. The purpose of this directive is to ensure that all “Relevant Apparatus” marketed in the European Union have the same EMC margin in the same type of environment. Relevant apparatus is defined as a product or installation having an independent function and being delivered to the end user as such in the European Union. Such apparatus must also be marked with the CE mark to show the end user that the product complies with relevant parts of the regulations.

The Machine Directive containing regulations of machine safety and structure, demands that the machine complies with the requirements of the EMC directive. This means that emissions from the machine (conducted and radiated) must be under the levels stated in the appropriate basic standards and the immunity of the machine for interference must be on the levels stated in these standards. These basic standards are:

EN50081-1	emissions, domestic and light industry
EN50081-2	emissions, industrial
EN50082-1	immunity, domestic and light industry
EN50082-2	immunity, industrial

It is not necessary to maintain the same levels inside the application. Therefore the regulations do not apply to components and materials used in the machines as such. Also, the amount of emitted interference increases as the number of components increases. This increase varies according to the nature of the source.

While it is always necessary to maintain a suitable EMC margin inside the electrical system of a machine to ensure the proper operation of the machine, the cost effective way to build an EMC directive compliant machine is to design for the external connections and protection of the machine to comply with the necessary requirements.

Typical methods to achive this are common filtering of power signals, appropriate housing structure for components and equipment and use of suitable screening and cable types together with correct grounding in the wiring of the system.

2.6.2 General installation guidelines

To help the machine manufacturer achieve compliance, ARLACON MC products have been measured in test installation to pass the requirements of EN50081-2 and EN50082-2.

These installations are described in ARLACON MC manuals. By following these installation practices the ARLACON components in the electrical system of the machine generally do not obstruct compliance. In complex cases, where it is difficult to install according to all instructions, and when the influence of other components must be considered, additional testing may be necessary to ensure compliance.

2.6.3 System grounding

The applicable regulations for protective earth of the system should be obeyed to ensure electrical safety.

Earth conductors used should be as short and large as possible and the must be able to carry the maximum short circuit current in a fault situation.

The control system, other electrical equipment and the machine must be interconnected to a common earth reference, the machine chassis earth.

Whenever possible, earth from control components and signal wiring shields should be connected to a separate earth called technical earth (TE), which is connected to the protective earth (PE) as near the factory earth potential as possible.

Shields and earth wiring conducting emitted interference to earth, such as motor power cable shields and motor/drive earth should be connected to PE.

To ensure, that all earths are as free of interference as possible, all earth wiring must be connected in a tree fashion with branches routed to the central earth ground point (see. fig. 2.6.3.1 and fig. 2.6.3.2).

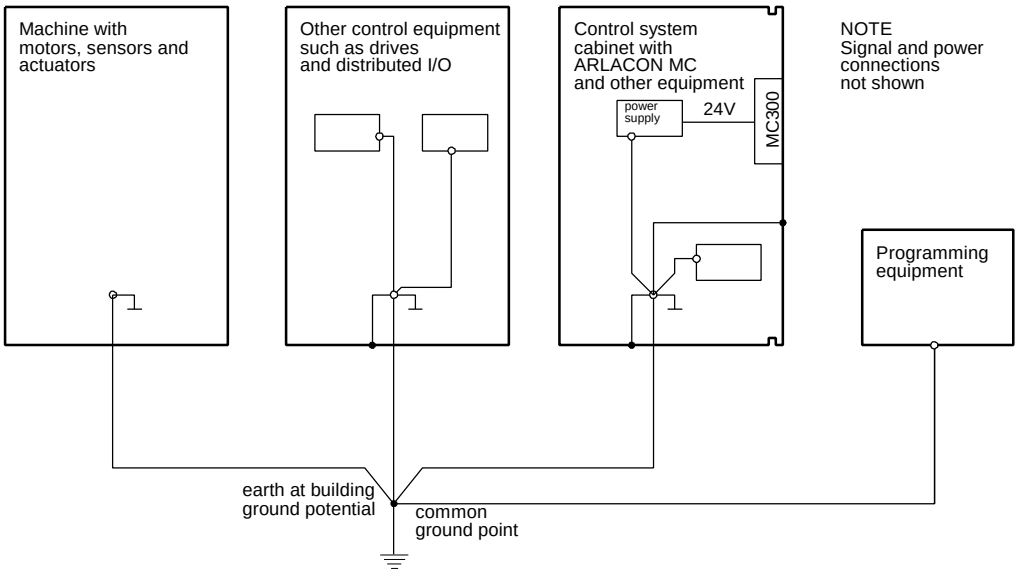

Fig. 2.6.3.1, System ground tree arrangement

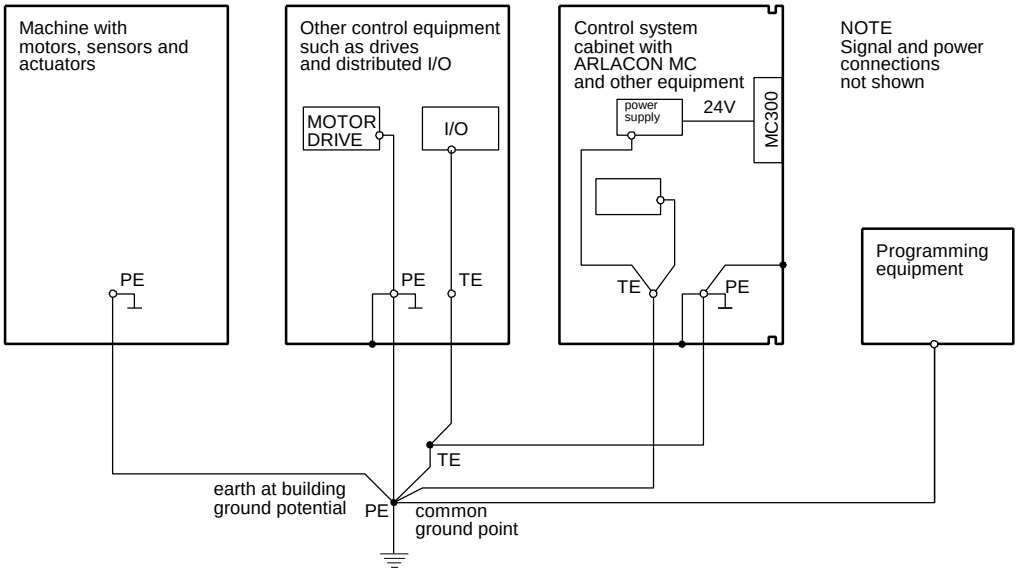

Fig. 2.6.3.2, Recommended ground arrangement with PE - TE

2.6.4 Enclosure

Install the equipment in a metal housing or equivalent. When installing a flush mount control unit, make sure that all fastening screws make good electrical contact with the door or panel where the unit is mounted.

System wiring external to the enclosure must be routed in metal conduit or equivalent shielded cables must be used. For best results, use cables with double screen and connect the outer shield to the enclosure at entry and the inner shields to TE near equipment.

Use ferrite rings with suitable permittivity, such as supplied by manufacturer, for external signal cables with shields wired to TE to reduce common mode interference and load to TE.

2.6.5 Power supply

Use a 24V power supply delivered by your ARLACON distributor. To comply with EN50081-2 requirements use a twisted pair of wire to feed the control unit and install the ferrite ring supplied with the unit according to fig. 2.6.5.1

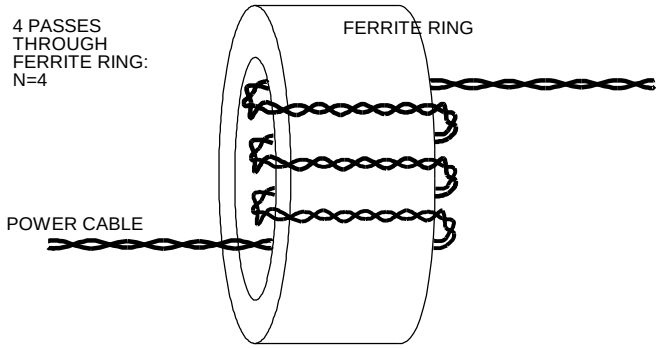

Fig. 2.6.5.1, Ferrite ring suppressor in power cable

If EN50081-1 levels for conducted emissions are necessary, use an additional RF filter available from your Arlacon distributor.

2.6.6 MC300 flush mount connections,

Fig. 2.6.6.1 shows the recommended power supply and earth connections for MC300 flush mount control unit.

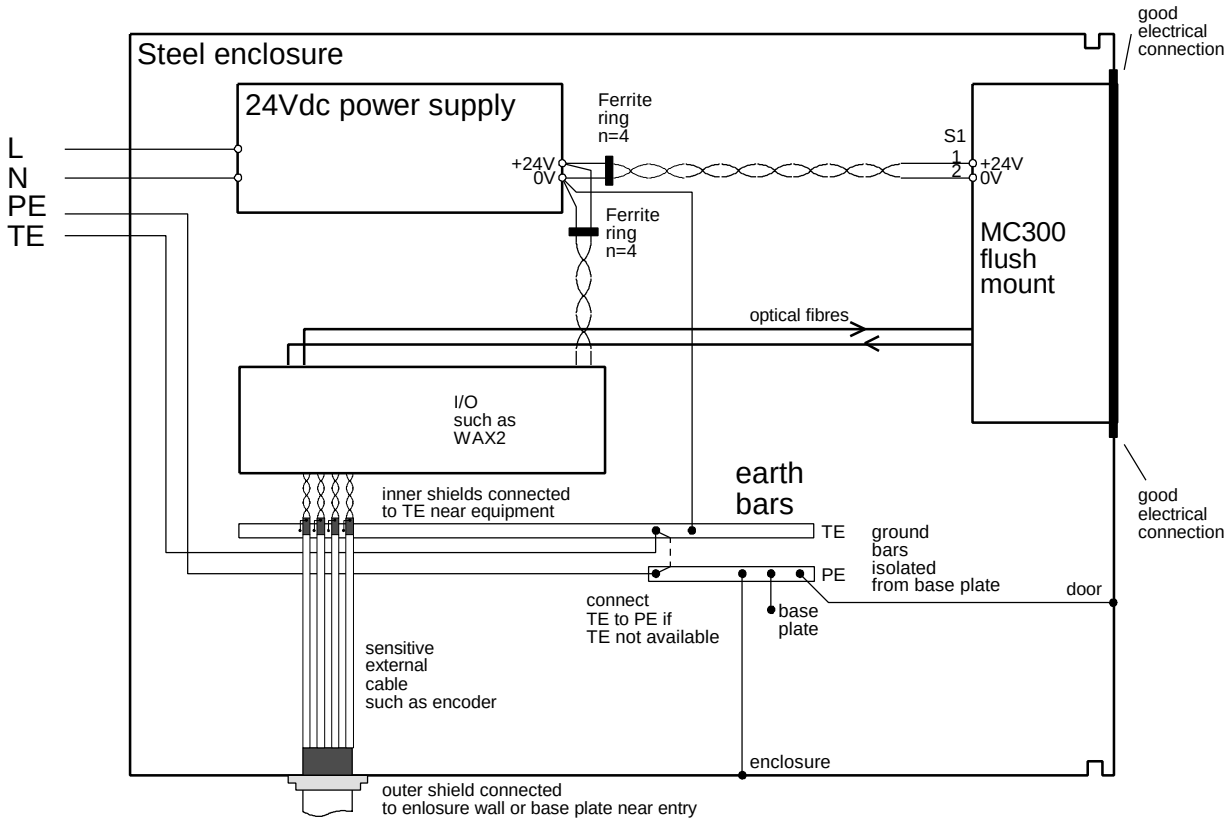

Fig. 2.6.6.1, MC300 flush mount, power supply and earth connections

2.6.7 MC300 with enclosure, connections

Fig. 2.6.7.1 shows the recommended power supply and earth connections for MC300 control unit with enclosure. The same cable with a sufficient number of twisted pairs can be used for other signals such as communications signals. Use a separate earth wire with sufficient copper diameter (2,5mm^2 or more) to ensure good earth connection for the control unit.

If you use the same cable for connecting emergency signals, do not distribute emergency loop wiring to areas with electromagnetic disturbances without taking precautions to keep them from entering the MC300 cable.

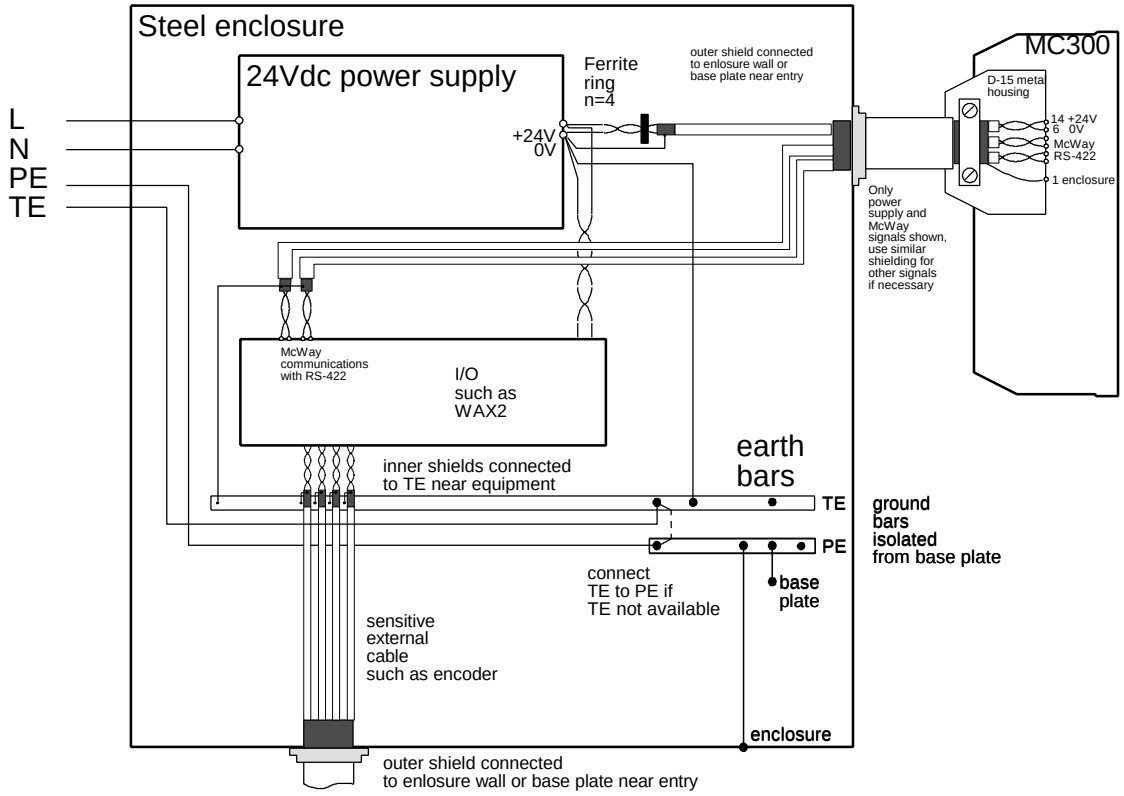

Fig. 2.6.7.1, MC300 with enclosure, power supply and earth connections

2.6.8 Signal cables

To conduct signals such as communications or transducer signals use shielded cables with preferably twisted pair wires when applicable. The shields of the wiring must be connected to earth potential with minimum interference (generally TE or earth star point). Signals using the shield for protecting themselves from outside interference must be connected to earth at the control cabinet. The other end of the shield must be left unconnected to avoid loops. When necessary, use ferrite rings on the cables to suppress common mode interference and keep it away from the system earth.

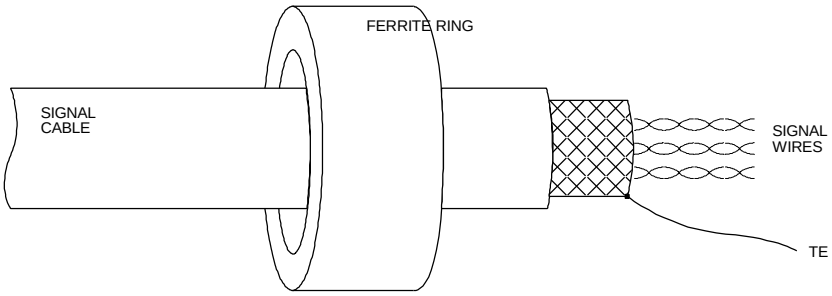

Fig. 2.6.9 Signal cable ferrite suppressor

3. POWER UP AND TESTING

To start your MC300 system please follow the procedures in this chapter. Assume that the system is now connected to power supply and a programming terminal (PC) and the connections have been made for possible i/o system.

Start the terminal and possible communications program for full duplex on-line communication.

3.1 SWITCHING ON POWER

Start the control unit by turning on the 24V supply. Control units with display will turn on the keyboard leds for 1 s and the display cursor will appear on the display.

If a McWay i/o system is connected, some of the led lamps on the i/o modules will turn on.

If not otherwise programmed in a WAKEUP.EX file, the system will display a message:

```
McDos 2.1
D8:/>
```

starting the McDos operating system of the MC300. The prompt D8:/> shows that the current drive and path is D8:/. There are 3(4) memory devices in the MC300 relevant for McDos all using a similar file and directory structure as found on diskettes etc. These are named:

- D2: CMOS RAM drive with configurable size (when 1M RAM installed)
- D6: Flash eprom drive programmable from within McDos/McBasic
- D7: CMOS RAM drive with configurable size
- D8. EPROM drive (read-only) with boot information and system files

The boot program will scan the devices in this order looking for MCDOS.CK file (resident part of McDos). If found, the respective MCDOS.CK is started. If no MCDOS.CK is found, the default McDos version included in the boot section of D8: is started. At this phase the drive where MCDOS.CK was found, or D8:, is set as the current drive (D0:, default drive for file operations).

After starting, McDos scans again the memory devices for a file named WAKEUP.EX (the start-up batch file). If found, McDos executes the commands contained in the file. McDos leaves the drive where it finds WAKEUP.EX as the current drive (D0:) unless not otherwise set by the commands in the file.

The default WAKEUP.EX is located at D8: containing the following commands:

```
PATH D6:/,D7:/,D8:/
BAS300
```

These commands set the search path for executable files (.CK and .EX) to include roots of all memory devices and starts the McBasic version for MC300.

The programmer may want to override this file by saving his own WAKEUP.EX in D7: during development work and saving the final version of it in D6: after completing the work. WAKEUP files can be edited with the McDos TX text editor.

McBasic can be started either without program file name

```
BAS300
```

to start McBasic with the program currently in work memory, or if the work memory is empty, in the command mode.

or with one or more program file names

```
BAS300 PROG1[,PROG2,....,PROGn]
```

to load and start the specified programs.

If McBasic starts without specified program names and finds that the work memory contents has been changed, it looks for a program file with name WAKEUP.BA from the current drive (D0:). If found, McBasic loads and runs the program contained in it. If no WAKEUP.BA exists, McBasic remains in command mode and a message “EMPTY MEMORY” is displayed on the console.

After starting in command mode, McBasic operates as follows:

When started without program If the control unit program memory is empty, a message

McBasic (version.revision)

```
        Program
        System tables
        Variables and compilations
        Recycled
nnnnn   Free

B>
```

will appear on the terminal screen. This message is the status message of the McBasic programming environment with the McBasic command level prompt. At the prompt

```
B>
```

the user can always type McBasic commands, study system status and edit programs. With the RUN command the user can start program execution. With ctrl+X the user can stop the program at any time. For more details please study the McBasic manual.

3.2 INITIALIZING THE SYSTEM

To be able to use certain system functions such as the McWay i/o system or servo control, some initialization procedures are necessary.

3.2.1 McWay configuration

To use McWay modules in MC300 their communication baud rate must be set to 1,25M.

Set the configuration of the installed I/O system using the McBasic WAYMOD$= command.

Command	Set McWay configuration.
Syntax	WAYMOD$(*n1*,*n2*)=*string*
n1	Number of McWay loop (0 for MC300).
n2	Number of McWay module in the loop (0 ...)
string	Type of module and settings

The number of McWay module *n2* refers to the order number of the module starting from the module connected to MC300 McWay out (module number 0) in the order they are connected in the McWay communications loop.

To determine the right settings for each I/O module type please refer to the ARLACON McWay Distributed I/O System User's Manual.

MC300 has a McWay I/O loop with 504 bits in and 504 bits out. The number of bits used by different modules depends on the module type.

The module types available in MC300 are:

type	function	bits out	bits in
EMPTY	empty module number	0	0
END	end of McWay loop	0	0
WOU	16 relay output module (WOU02000)	16	0
WOA	6 isolated analog outputs (WOA02004)	96	0
WIN	24 inputs isolated input module (WIN02001)	0	24
WIA2	2 isolated analog inputs (WIA02313 set for 2 inputs)	0	32
WIA4	4 isolated analog inputs (WIA02313 set for 4 inputs)	0	64
WIA6	6 isolated analog inputs (WIA02313 set for 6 inputs)	0	96
WIA	same as WIA6	0	96
WAX	Servo axis connection module with i/o, incremental encoder	32	32
WAX2	Servo axis connection module with i/o, incremental encoder	32	32
WAX2A	Servo axis connection module with i/o, SSI absolute encoder	40	40

By configuring the McWay you set the sequence of modules in the McWay loop forming the i/o system. At the same time you set the logical addresses for the i/o connections available on the modules.

To use all loop capacity it is necessary to place modules using only output bits before modules using only input bits in the loop. The reason for this is that McWay modules can use the same bit positions in data frame for transferring input data to MC300 after they have transferred output data to output modules.

Analog and digital output modules use only output bits and input modules only input bits. The axis connection modules use the same number of input and output bits, but it is most efficient to put them first in the the loop as a different number of input and output bits before them consumes unused bits.

The logical axes with letter references in MC300 are X,Y,Z,W,A,B,C,D,T and U. Axes can also be referenced by their numbers 0..15. The first ten axes have both letter names and numbers whereas axes 10..15 can only be referenced by their numbers (see table below). For information about command syntaxes see McBasic documentation.

Max. 15 physical axes can be connected to the system with axis connection modules. Axes not used as physical axes can be used as virtual axes in conjunction with command like FOLLOW and MOVEPROF.

The default DRIVETYPE for the first four axes (X,Y,Z,W) in MC300 is 1 (standard closed loop with ±10V reference) and 176 (virtual) for all other axes. Use the McBasic DRIVETYPE= command to set axes according to your needs. When configuring connection modules to the I/O system, following references are used for INP(*a*) (and OUT(*a*)) in configuration strings for axis connection modules.

axis letter	axis number	McWay address *a*
X	0	0
Y	1	4
Z	2	8
W	3	12
A	4	16
B	5	20
C	6	24
D	7	28
T	8	32
U	9	36
	10	40
	11	44
	12	48
	13	52
	14	56
	15	60

It is recommended that addresses 0 ... 63 not be used for i/o other than axes control as in many MC300 configurations and other ARLACON MC control systems they are used for motion control purposes.'

3.3 STARTING THE SERVO SYSTEM

To use the MC300/WAX2 servo control features, it is necessary to set some McBasic motion control parameters.

The MC300 based motion control system consists of the drive system usually forming an inner speed control loop and the outer MC300 position control loop.

When the McBasic command or application program activates the MC300 motion control software, the position set value in the system starts to move as a function of time to form the image of the motion.

The position regulator continuously calculates the speed reference value for the drive to hold the actual position as close to the set value as possible, thus performing the actual motion according to the set value motion.

The operation of the position regulator can be adjusted with four parameters:

GAINx	PID gain factor (0...65535)
INTGx	PID intergrating factor (0...255)
DERVx	PID derivating factor (0...255)
SCOMPx	Speed compensation (distance units/s)

Where x is the name of the axis involved (X, Y or Z). Alternately, syntaxes with number references for axes can be used. This also allows indirect referencing:

```
FOR n=0 TO 15
 GAIN(n)=150 : INTG(n)=0 : DERV(n)=2
 NEXT n
```

See McBasic manual for more information.

Fig 3.3 shows the principle of the servo control system for one axis.

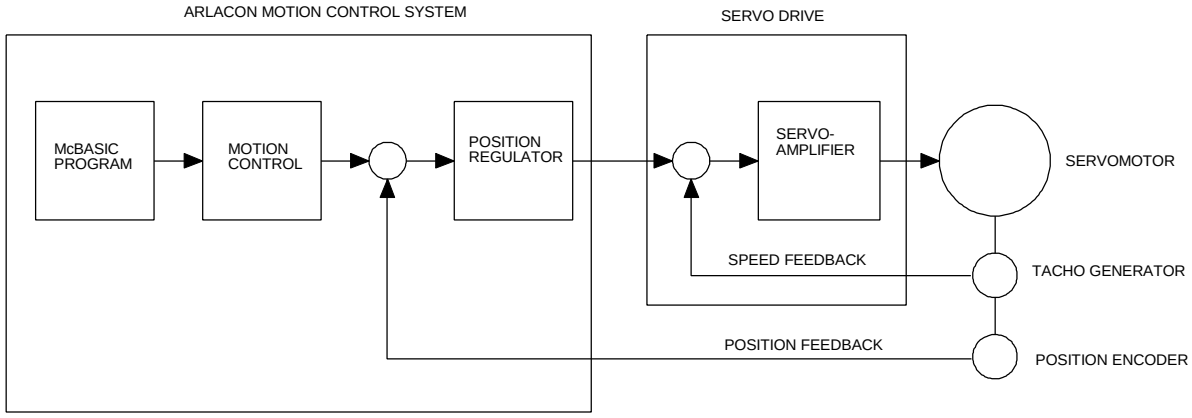

Fig. 3.3 Servo control architecture

Additional parameters that may have to be set before using servo control are:

PIDFREQ	Repeat rate of position control algorithm (50...2000), default 400 common for all axes
RESx	Position scale (pulse edges/programming unit usually mm)
MAXERRx	Maximum servo position error
LIMITTYPEx	Mode of operation for limit switches
DRIVETYPEx	Mode of operation for drive control (REF/ENA)
SPEEDx	The maximum speed used in motion
ACCELx	The acceleration used in motion
FILTERSIZEx	Position reference smoothing filter for generation of limited da/dt (S-ramp generation)

To study the operation of the parameters in more detail, please refer to the McBasic manual.

As an example of the servo parameter initialization a system might have the following X axis initialisation in the beginning of a program:

```
PIDFREQ=500
RESX=125   ' 125 pulse edges/mm
MAXERRX=10 ' poserr >10mm cuts off servo
GAINX=100  ' gain
INTGX=0 : DERVX=0 : SCOMPX=0 ' others off
SPEEDX=200 ' 200 mm/s
ACCELX=400 ' 0.5 s ramp (200/400=0.5)
FILTERSIZEX=20 ‘ 40ms filter (20/500 seconds)
```

To start moving the X axis, use the PWRX=1 command to start position control. The amplifier will go active and the position regulator will start holding the position.

To start a system with high speed capability, use a lower value, like PWRX=0.2 to limit the regulator maximum output (max output = 10 x PWRX [volts]).

If the system is unstable, runs away from the set position and cuts off at MAXERR, check encoder phasing and speed loop phasing.

To operate the REF output without the speed regulator, use the OPWRX= command.

When the position regulator is running, use the MOVE command to try moving the axis to new positions.

Adjust the GAIN,DERV,INTG and SCOMP parameters for stable operation. For many systems with tacho speed loop the parameters can be set by adjusting GAIN while leaving DERV, INTG and SCOMP to 0 and then adding DERV if necessary.

After the feedback parameters are set, SCOMP may be set at a value corresponding the speed of the axis when REF is 10V (this is called critical SCOMP). This will add a feedforward part in the REF signal compensating for the known part of the speed reference during motion and thus enabling accurate path control. Using a SCOMP value higher than the critical value causes undercritical SCOMP that compensates only partly for the position lag when in motion.

To disable speed compensation, leave SCOMP at 0. Critical SCOMP also provides the fastest point-to-point positioning. Undercritical or no SCOMP causes smoother operation at the end of the motion to avoid overshoot.

INTG can be used to integrate the position error for minimum error at constant or zero speed. The best INTG operation is achieved with high speed servo components and critical SCOMP.

4. PROGRAMMING THE MC300

To use the McBasic programming environment of the MC300 please note the considerations in this chapter.

4.1 SYSTEM SPECIFIC MCBASIC FEATURES

The McBasic environment in the MC300 operates under the McDos operating system, so you can enter the operating system level with DOS, SYSTEM or X command.

Following devices are as default available for OPEN command and thus input/output commands and functions.

CN:	console serial communications channel (default)
LP:	auxiliary serial communications channel
TR:	display and keyboard
R1:	CMOS RAM file 8Kb with no filename
D2:	CMOS RAM drive default 48Kbytes when 1M RAM installed, configurable
D6:	FLASH EPROM drive, with file system
D7:	CMOS RAM drive default 16Kb, configurable, with file system
D8:	EPROM (system) drive, with file system

If necessary, all device numbers D1: ... D8 can be configured using the McDos SET command as RAM, FLASH or EPROM drives according to available RAM and application needs. While several RAM drives of different sizes can be used, only one device can be set as FLASH and one as EPROM.

4.2 DISPLAY AND KEYBOARD

The display and keyboard in the MC300 can be used from programs by opening it for a suitable logical device number:

```
OPEN #5,"TR:"
```

Keypad and keyboard

Keystrokes can be read from the keypad or connected ASCII keyboard using the McBasic BYTE function:

```
DO
 A=BYTE(#5)
 IF A=CHR$("1") THEN GOSUB SomeSubroutine
 UNTIL A=13 ' enter key
 LOOP
```

The display and keypad led lamps can be controlled using the ARLACON display terminal commands as described in the ARLACON displays manual.

Fig. 4.2.1 shows the characters generated by pressing the MC300 keypad keys. Numbers shown below the key characters are used as references when addressing the key led lamps with the respective control sequence.

E 200	F 201	G 202	H 203
I 204	J 205	K 206	L 207
A 208	7 209	8 210	9 211
B 212	4 213	5 214	6 215
C 216	1 217	2 218	3 219
D 220	bs 221	0 222	cr 223

Fig 4.2.1 Keypad default output characters and led adresses

After opening the display and keyboard can be used as they were a separate ARLACON terminal connected to #5, for example. To write to the display use the PRINT #5 or BYTE(#5)= command and to read from the keyboard use the BYTE(#5) function or the INPUT#5 command.

ASCII -keyboard

An ASCII keyboard can be connected to the standard 5-pin connector in the end of the MC300 version with enclosure. In the MC300 flush mount version a keyboard can be connected to S6 on the system board using an optional adapter cable (50cm) supplied separately. With the adapter cable the keyboard connector can be installed conveniently near the unit.

The ASCII keyboard is a standard AT keyboard with a Ø13mm DIN connector. It operates in paraller with the internal keypad, so all characters are stored in the same input buffer and can be read from the same device number. The operation of the keyboard and generated keycodes are described in detail in the ARLACON displays manual.

Display

The LCD display of MC300 can show text and graphics as printed from the system to the device number opened for TR:. The display screen is 40 normal size characters wide row and 30 rows high. The size of characters, character set and other display functions can be selected/used with the control codes described in the ARLACON displays manual. When printing graphics, the screen has a resolution of 320x240 pixels. The most convenient way to

print graphics on the screen is to use the McBasic graphics functions as decribed in McBasic manual.

To adjust the screen contrast for optimum viewing angle, open the back cover of the unit and adjust R26 (see fig. 2.2.1).

For more details on the use of terminal keycode programming, control sequences etc. please refer to the ARLACON displays manual.

4.3 I/O USAGE

After configuration the inputs and outputs of the MC300 are available for use with the INP( ) and OUT( ) functions of McBasic.

For example:

```
OUT(200)=1    'turn on OUT(200)

DO UNTIL INP(35)=1 : LOOP 'wait until INP(35) on
```

For more details refer to McBasic manual.

A special feature of the MC300 McWay based i/o is the error values. In addition to the usual 0 and 1 the INP( ) and OUT( ) funtions can return negative values

-1 if there is a fatal communications error in McWay data transmission.
-2 if the module for which the i/o address is configured is not present in the McWay loop.

4.4 EDITING IN A PC

To edit your application program in a PC you can create an ASCII file and edit with a suitable editor or word processor program.

To load the program to the MC300 control unit, use a terminal program capable to transfer ASCII data with xon/xoff handshake. If using linenumbered code, the program can be downloaded to the system as such. When using code with no line numbers, start loading the program with a command:

```
LOAD "CN:"
```

After downloading the program, use ctrl-X from console to exit loading. If a syntax error is detected when loading a numbered program, the faulty line will be left away. When detecting a syntax error while loading an unnumbered program, McBasic exits load mode and stops loading program.

Error messages are generated and send to console respectively.

4.5 USING PROCOMM

A suitable terminal program for use with MC300 is the PROCOMM or PROCOMM+ (PCPLUS) communications program.

To set PROCOMM for terminal and data transfer use with MC300, the terminal options, ascii transfer options and line/port setup must be set to suit MC300 communications.

The following default settings can be used (PROCOMM +):

Line/port setup (Alt P)

Use the port you wish with
9600 baud
8 bit data
no parity
2 stop bits

Terminal options (general) (Alt S)

Terminal emulation	VT320, VT102 or ANSI
Duplex	full
Software flow control (xon/xoff)	on
Hardware flow control (rts/cts)	off
Line wrap	off
Screen scroll	on
CR translation	cr
BS translation	non-destructive
Break length	1000
Enquiry	off

General options (Alt S)

Exploding windows	off
Sound effects	off
Alarm sound	on
Alarm time	0
Translation table	off
Pause character	(no entry !)
Transmit pacing	0
Call logging	off
Filename lookup	off
Menu line	on
Menu line key	`
Snow removal	off
Remote commands	off
Enhanced kb speedup	on (off)
ANSI compatibility	3.x

Ascii transfer options (Alt S)

Echo locally	no
Expand blank lines	no
Expand tabs	no
Character pacing (millisec)	0
Line pacing (1/10 sec)	0
Pace character	10
CR translation (upload)	none
LF translation (upload)	strip
CR translation (download)	none
LF translation (download)	none
Strip 8th bit	no

4.6 MEMORY

4.6.1 Flash memory and program backups

To ensure reliable operation and minimize down-time of applications it is advisable to save the application program and possible critical data files in the MC300 FLASH EPROM after finishing program development. Saving the program with the filename “WAKEUP.BA” allows automatic loading of the program in case the program is lost from the work memory.

To save the program currently in work memory, stop the program (ctrl-X) and use the command:

```
SAVE "D6:WAKEUP"
```

Before doing this, delete the previous WAKEUP.BA from D6: if it exists. Deleting does not free the memory used by the previous version, so if necessary, you must clear the entire D6: using the command:

```
CLEARFLASH      from McDOS
                  or
.CLEARFLASH     from McBasic
```

4.6.2 Memory settings

To adapt to different memory circuit types it is necessary to set the jumpers at S5 (see fig. 2.3.1) to correct positions according to the type used.

The leftmost 6 pins of S5 are used to specify U1/U3 RAM chip type, the center 6 pins the system eprom U2/U4 type and the rightmost 6 pins the flash eprom U5 type.

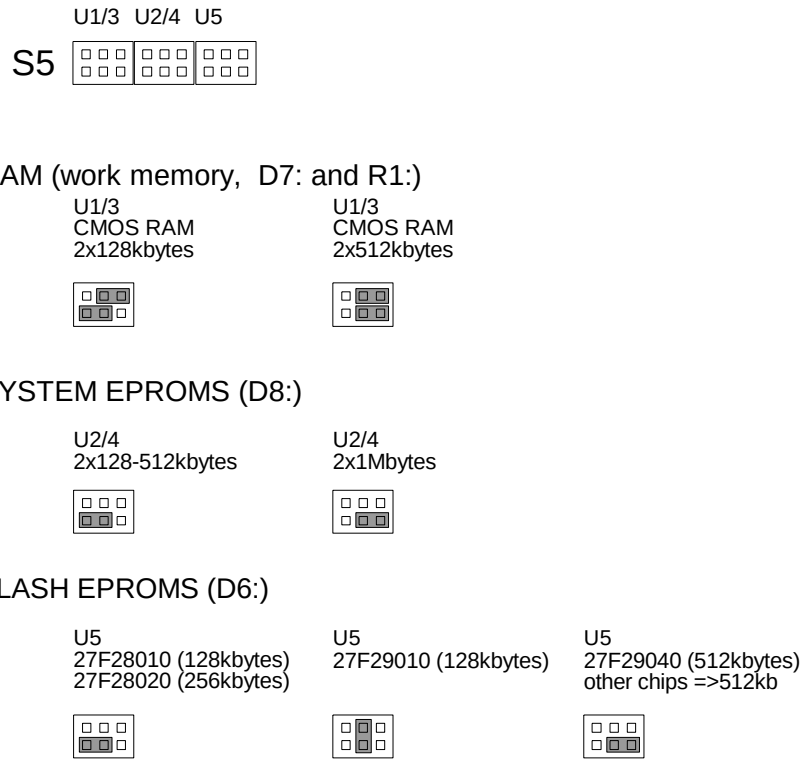

Fig. 4.6.1 S5 settings for different memory types

4.6.3 RAM memory

RAM memory is used in the system as program space, program variable space, system program workspace, RAM file and communications buffer space. The MC300 is equipped with 256 Kbytes of RAM memory as standard. It is possible to replace it with larger memory chips for 1Mbyte of RAM memory.

Using the McDos SET command it is possible to set the amount of RAM memory reserved for use as the RAM drive D7:.

4.6.4 Real-time clock and calendar

MC300 is equipped with a real time clock and calendar, which is used via McBasic DATE$(#1) function and command.

4.6.5 Emergency stop switch

An emergency stop switch is available for the MC300 with enclosure. It is installed as shown in fig. 2.2.2.

Pushing the emergency stop switch cuts the connection between pins 8 and 15 at the :CN connector (D-15). See chapter 2.3.3 for more details.